

# Brief on Achievements of the 'Improving the Rural Livelihoods in Southern Africa project: 2004 to 2010

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From 2004 to 2010, the Southern Africa Root Crops Research Network (SARRNET), coordinated by the International Institute of Tropical Agriculture (IITA) with technical backstopping from IITA on Cassava and from the International Potato Center (CIP) on sweetpotato and potato, executed the USAID/SA funded project on Improving Rural Livelihoods in Southern Africa (SA) through use of root and tuber crops in the

countries.

This brief highlights the major activities and achievements of the project during that period.

## Cassava, yam and cocoyam

Several improved cassava germplasm from IITA in form of botanical seeds (tens of thousands), stem cuttings (259 clones) and tissue culture (>326 clones) were introduced into the region and locally evaluated in Angola, Malawi, Mozambique and Zambia. From earlier introductions, seven improved varieties in Malawi (Phoso [LCN8010], Mulola [83350], Chiombola [TME 6], Sagonja [CH92/082], Mpale [NDL90/34], Kalawe [CH02/0066] and Chamandanda [01/1313]) and five in Mozambique (Colicanana [04/2000], Nziva [04/1855], Okhumelela [04/763], Orera [04/540] and Eyope [04/433]) were officially released (Fig. 1). Many more potential genotypes were in advanced stages of evaluation mainly in Angola and Zambia.



Fig 1. IITA root and tubers program team with the SARRNET coordinator appreciating one released varieties in Nampula, Mozambique

Chinyanja Triangle (eastern province in Zambia, Tete province in Mozambique, and central and southern regions of Malawi), Angola and Swaziland. The project activities followed the USAID/SA strategic Objective 15 on improving rural livelihoods in SA and responded to Intermediate Result 2 which aims at diversifying agricultural production in vulnerable communities to enhance food and income security through root (cassava) and tuber (sweetpotato, potato, yam and cocoyam) crops.

The activities were implemented in collaboration with the national agricultural research systems (NARS) and other institutions/organizations such as Total Land Care, International Development Enterprises in Zambia, Citizens Network for Foreign Affairs/International Center for Tropical Agriculture (CNFA/CIAT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), CARITAS of Angola, the University (Bunda College in Malawi; Copperbelt University in Zambia, Eduardo Mondlane in Mozambique, Agostinho Neto in Angola), Concern Universal in Malawi; World Vision-Angola, Universal Industries Ltd in Malawi; ASNAPP-Zambia, farmers and farmers' organizations in the participating

A pilot cassava starch processing plant at Masinda, Malawi uses a local variety, Mbawala, for starch extraction. The variety has a starch extraction rate of 17 %. A study to evaluate cassava genotypes for high starch extraction showed that Gomani, Sauti, TME 6, Mkondezi, CH92/082 and CH92/102 had higher (20-23.8%) extraction rates than Mbawala. CH92/082, TME 6 and Sauti were thus distributed to farmers in Masinda for production.

Evaluation and selection of cassava genotypes for high root beta-carotene content was initiated. In Malawi highest levels of carotenoids (7.3-10.5 µg /g) were in clones 01/1224, 01/1380, 98/2132, 01/1371, 01/1335 and 01/1277 while the lowest (<0.7 µg /g) were in white fleshed clones, Mbundumali and NDL90/034. However, most of the yellow root clones were bitter tasting and low in dry matter (DM) content (<30 %) and therefore not suitable for fresh market. A crossing program was initiated in 2009/10 to increase the probability of increasing beta-carotene and dry matter content.

Evaluation and selection for frost tolerance was also initiated. In Zambia the local genotypes (Kariba, Chila and Kampolombo) were found more tolerant to frost (no damage) than most introductions (damage score of >2.0). On the other hand, in Mozambique all the clones succumbed to frost, resulting in severe die-back, stunted growth

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(height of <1 m) and very low root yields (7.4 t /ha). Nonetheless, some clones (MPUNK 2, 96/0016, Nikwa, MGT9803 and 3MZ) performed comparatively better (root yields of >9.0 t /ha) and were selected as potential clones for frost-prone areas. Similar results were found in Swaziland with Mphundle cultivar performing relatively better than the other genotypes despite the severe frost effect (score of 4.3).

A total of 63 cassava, 42 yam) and 73 cocoyam accessions in Malawi, 11 cassava accessions in Angola, 11 yam and 11 cocoyam accessions in Mozambique and 19 yam accessions in Zambia were collected. The objective was to maintain the germplasm as source of genes for farmer desired traits for incorporation into the new varieties and to minimize loss and or/genetic erosion of the local varieties.

A vertical cassava stem (planting material) storage technology was released in Malawi following studies which showed that big-sized stems such as those of Mbundumali and Mkondezi, under well ventilated shed, can be stored for 3 to 4 months without significantly losing viability when stored in a vertical position. The technology has potential of being scaled out to other countries.

Studies on response of 16 cassava genotypes to fertilizer application did not show any significant increases in root yield and DM content in Malawi despite the low soil N content, calling for further investigation. However, similar studies on sweetpotato showed significant ( $P<0.0001$ ) increases in tuber yield with N application at Makoka but not at Chitedze and Chitala. However, it was not economical to apply more than 30kg N/ha.

Four pre-emergent herbicides (Bullet, Harness 90 EC, Codal Gold 412-5 EC and Metalachlor 960 EC), with and without follow-up hand hoe weeding, were evaluated in Malawi. Results showed that the herbicides reduced early weed growth by 53.7 to 97.9% with no deleterious effect on plant establishment. Bullet was the most effective, resulting in root yields and returns comparable to hand-hoe weeding. A similar study in Zambia showed that use of Paraquat was the most cost-effective and that hand hoe weeding was the most expensive in weed control.

A study to evaluate cassava genotypes for intercropping suitability with maize and pigeon pea in Malawi showed that clones 83350, TME 1, LCN 8010 and TME 7 were the best for intercropping with maize and that clones 83350, 182/00576, Mbundumali, and TME 1 were the best for intercropping with pigeon pea.

A study conducted to determine appropriate planting dates for cassava in Zambia showed that the highest stem and root yields are obtained when cassava is planted before mid-January.

For seed multiplication and dissemination, a total of 30,448 bundles of cassava stems to plant 341.6ha were distributed to 3,215 farmers in the Chinyanja triangle while 7,462 bundles of stems enough for 86.2ha were distributed in Angola. In addition, 9.6 and 6.5ha of primary multiplication nurseries were maintained in 2007/08 and in 2009/10, respectively in Angola.

The cassava silage technology was released in Malawi in 2007. The silage is made by ensiling a mixture of chopped cassava leaf foliage (80 %) and roots (20 %) for at least 21 days. When fed as a supplement to lactating dairy cows, milk yield increased by 40%, butterfat content by 25% and gross income by 40% compared to maize bran and by 30 % compared to maize silage. The technology has potential for scaling up and out.



Fig 2. Producers and entrepreneurs being trained in HQCF production at IITA Malawi, for making different cassava-based products

The study in Malawi to evaluate the effect of replacing maize with cassava on broiler chicken production showed that up to 20% of the maize meal could be replaced with cassava meal without adversely affecting live and dressed weight, dressing percentage, and returns per bird at seven weeks of age. Similar work on use of cassava flour



for bread and confectioneries showed that up to 20% of wheat flour could be replaced with that of cassava flour without affecting quality of the bread.

Pilot cassava processing centers were established in Malawi and Mozambique for processing high quality cassava flour (HQCF) and cassava starch in Malawi. The centers provided business for the entrepreneurs, training grounds on cassava processing and markets for fresh roots to cassava



Fig 3. Participants to the on-farm evaluation making their classification to one of the clones at Umbeluzi, Mozambique

growers around the processing centers.

Following SARRNET phases I and II on introduction and adaptation of processing machines (chippers, graters and presses), more processing machines were later fabricated and distributed to processing centers and entrepreneurs for processing HQCF and starch. Work was also initiated to develop a cassava peeler and a solar dryer to reduce processing costs and improve quality of the processed products.

A study to assess fungal and mycotoxin contamination in processed cassava showed that most products (mostly cassava chips stored at household) in Malawi and Zambia are safe for consumption as their levels of aflatoxins ( $<2.0 \mu\text{g} / \text{kg}$ ) are much lower than the world median total aflatoxins maximum tolerable limit of  $10.0 \mu\text{g} / \text{kg}$ . Similarly most households in Mozambique consume cassava flour with low linamarine (3 to 7 ppm), mould and yeast (300 to 530 UFC /g).

The project promoted and strengthened information exchange. This was mainly done through the ROOTS Newsletter (8 were published), meetings ( $>13$  were conducted/attended), conferences (ISTRIC-AB in 2004, 2007 and 2010), backstopping, production of posters and handbooks

and publication of scientific articles ( $> 100$  were published).

The impact study conducted in 2010 showed that the project distributed over 44,412 bundles of cassava stems for 683ha and introduced improved cassava germplasm, processing equipment and management practices. The project trained over 4,614 men and 2,920 women on cassava production and processing (Fig. 2) and 10,843 rural households, 8,743 vulnerable households, 21 agricultural-related firms, and 36 producer organizations, business associations, and CBOs directly benefited from the interventions.

### Sweetpotato

A total of 638 sweetpotato breeding trials were conducted (438 in Mozambique, 69 in Malawi, 50 in Angola and 81 in Zambia) involving 189,997 genotypes. Farmers and consumers actively participated in the evaluation and selection (Fig. 3) as evidenced by a large number (419) of on-farm trials conducted. In Mozambique, 15 new sweetpotato varieties were released, 6 with good adaptability and stability and 4 with good adaptability to Angonia, bringing the number of potential varieties that can be supplied to farmers in Angonia, South of Malawi and South Africa to ten. In Malawi, 59 of the trials were on-farm and four varieties were selected for multiplication and distribution. In Angola, 30 of the trials were on-farm and three varieties with good performance were selected and are being multiplied for distribution to farmers. In Zambia 8 new varieties were selected for massive multiplication and distribution to farmers in the country.

In Angonia (Mozambique), the project continuously rapidly multiplied Resisto, MGCL01. Jonathan, 199062.1, Kande, Japon selecto, Tainung 64, Caromex, Cordner and Gaba-gaba sweetpotato varieties already in use by farmers in addition to the 15 potential clones earmarked for release. Overall, there were 6.3ha of nursery fields from which about 4,500 farmers benefited. The project also worked with producer associations and prominent farmers and established 7.8ha of planting material for distribution to their affiliates. In decentralized vine multiplications 1ha of vines was established in 2009/10 and distributed to 682 farmers. In addition 13 decentralized vine multipliers were selected and produced 2.1ha of



vines which were distributed to about 1,500 farmers.

In Angola, 15.8ha of OFSP vines were produced since 2008. Rapid multiplication of novel OFSP was also conducted in all the four provinces of the project. A total 152 OFSP rapid multiplication fields were established in eight provinces for 50 farmer associations with 2,064 direct beneficiaries and 904 individual farmers. In Huambo, 3.97ha of sweetpotato vines were produced in 2009/10 and 17 rapid multiplication fields were established by farmers and associations. Chianga delivered 1.5 tons of vines of Lanceolada, Nemanete and MUSG 14 varieties to OIM for distribution to 800 families from DRC. In Huíla, Kwanza Norte, and Uíge, 0.19ha, 0.24ha, and 0.4ha, respectively, of multiplication fields were established.

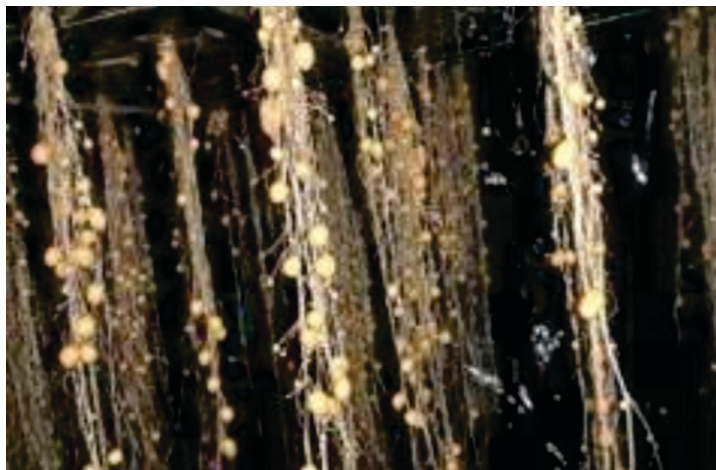
A new kitchen and laboratory with Near Infrared Reflectance Spectroscopy (NIRS) and freezer drier technology was constructed. These will be used for analyzing macro and micronutrients and DM content. Greenhouses were also built, 6 in Mozambique and one each in Malawi, Angola and Zambia.

In Mozambique, the activities were focused on renewing the 24 existing clones in the tissue culture laboratory and collecting and identifying locally-infected sweetpotato varieties for virus cataloguing. For virus clean up, 157 potential clones were used for meristem extraction to generate new tissue/in vitro culture material for thermotherapy. Meristem cultures of 17 clones are in the tissue culture laboratory, seven of these went through thermotherapy (Xiadha xa kau, UNK Malawe, Admarc, MGCL 01, Kande, 440170 and 440136).

A survey of sweetpotato virus diseases was conducted in Umbelúzi, Chókwè, Angónia, and Gurué districts. Plants with virus symptoms were collected for virus detection at the tissue culture lab using the NCM ELISA test. Results showed that apart from Angónia which has high virus infection (81.3%) Gurué or Zambézia has also very high infection (83.3% incidence).

A total of 307 trainings were conducted (232 on production, 50 on agro-processing/biotechnology and 25 on marketing) and 2,088 farmers and technicians (850 men and 1238 women) benefited.

In addition, 38 technicians from partners and government institutions benefited from technical training and capacity building. These were on Clone Selector, EXCEL friendly software for data analysis (9 technicians from CIP-Mozambique), virus



detection (2 technicians from CIP and 8 from NAR Institute), data analysis using SAS and PLABSTAT (5 technicians), data management on plant breeding (2 technicians from Angola), pathways analysis for monitoring and evaluation (2 CIP staff), collection/identification of sweetpotato viruses (1 virologist from the project), data management (2 senior CIP staff), use of pesticides for mite and whitefly control in the greenhouse (2 technicians from the project) and use of vacuum freeze dryer and NIRS/thermotherapy (2 CIP lab technicians).

The project hosted/assisted 31 students from universities and medium-level institutions. These included 3 MSc students from Universidade Eduardo Mondlane who conducted part of their practical work with CIP-Mozambique, 5 students from the Catholic University of Cuamba on production and breeding, 2 B.Sc. students from the Instituto Superior Politecnico de Gaza on beta carotene analysis and evaluation of in vitro multiplication rate in five sweetpotato varieties, 17 medium-level students from Boane and Gaza Agrarian Research Institute and 4 medium level students from Grue Agrarian Institute on sweetpotato breeding.

The project also supported local CIP partner programs through technical meetings. These included the Jacaranda Farmers company (interested in starting business involving potato and sweetpotato) and Hortícolas de Moçambique company (interested in commercial production of





OFSP), Millennium Village Program in Lionde, Chókwè (monitored their sweetpotato fields) and IIAM (trained 9 technicians on virus detection and facilitated attendance of two senior technicians at a workshop in Lesotho on establishment of a platform to harmonize aspects of production, processing and marketing of OFSP and other vegetable crops in southern Africa and supported the livestock program to delineate right animal feeding programs involving sweetpotato leaves and storage roots).



Fig 4. Golden bread made from wheat flour and OFSP

Several training workshops were conducted. These were on use of OFSP for golden bread (Fig. 4) (9 local bakers in Angonia attended) as part of the promotional program on sweetpotato based recipes, guided visit to screen houses (40 children from the Rede Criança as part of child education), sweetpotato activities in the tissue culture lab, screen houses and kitchen (30 participants on a workshop on sweetpotato catalogue and platform for southern Africa), field days in Gurúé (6 producer associations and farmers from Zambézia and Nampula) and Umbelúzi and Angonia (>1,000 participants) and a symposium on agrarian technologies (one paper on sweetpotato seed system in Mozambique and two posters on identification of the sweetpotato viruses in Mozambique and the establishment of the NIRS in Mozambique presented). The project received several visitors. Prominent among these were the Prime Minister of Mozambique who toured the new laboratory/kitchen where most of the tissue culture, DM content, and postharvest activities are conducted and senior staff of the Melinda Gates Foundation who visited the project in March 2010

### Potato

• From 2005/06 to 2009/10, CIP led the implementation of potato activities in SARRNET with funding from USAID Regional office for southern Africa. The activities were co-funded by the USAID bilateral mission in Mozambique for

activities conducted in Mozambique, Irish Aid-Malawi for activities conducted in Malawi, and Chevron for activities conducted in Angola. Target countries were Malawi, Mozambique, Angola and Zambia. Key results included:

- Knowledge of the Strengths, Weaknesses, Opportunities and Threats (SWOT) in the potato sub-sector documented in Malawi, Mozambique, Angola and Zambia.
- New high-yielding potato varieties with resistance to late blight disease and with good cooking and processing qualities selected in Mozambique, Malawi and Angola.
- Improved techniques for the selection of quality planting materials in farmers' fields (the positive and negative seed selection techniques) introduced, promoted and adopted by farmers in Malawi, Mozambique and Angola.
- CIP's low-cost method for seed potato storage - Diffuse Light Store (DLS) - introduced, promoted and adopted by farmers and scientists in Malawi, Mozambique, and Angola. An innovative seed potato multiplication system called 'aeroponics system' (Fig. 5) introduced, tested and officially released in Malawi; it was also being used in Mozambique.
- Manuals for training extension workers and farmers on seed potato selection through positive selection translated into Portuguese and Chichewa languages.
- Knowledge on the effects of different levels of NPK fertilizer on potato tuber yield in Malawi and Mozambique generated and documented.
- Training was conducted for national technical staff on potato tissue culture in Malawi (DARS technicians), Mozambique (IIAM technicians) and Angola; on use of aeroponics technique for seed potato multiplication in Malawi (DARS technicians, Universal Industries Ltd staff) and Mozambique (IIAM technicians), on use of positive selection technique to improve seed quality and use of improved production practices for farmers in Mozambique, Angola and Malawi, and on use of ELISA technique to detect seed potato diseases (viruses and bacterial wilt) for technical staff of IIAM-Mozambique and DARS-Malawi and CIP-Malawi.
- Capacity of extension workers in Malawi, Mozambique and Angola strengthened on seed potato production and on improved practices for potato production and seed storage (Fig.6).



*Fig 6. Training in potato seed production at IIAM Lichinga, Mozambique in 2009*

- Four M.Sc. students trained on potato research completed their thesis research on potato.
- A tissue culture lab was renovated at Bvumbwe and the pathology lab was renovated and equipped for potato disease detection at Chitedze Research Station in Malawi.
- DLS structures were constructed at Research Stations in Malawi (Bembeke), Angola (Chianga), and Mozambique (Lichinga) for seed storage and at some selected sites for promotion to farmers in Malawi, Mozambique and Angola.
- Public-private sector partnership created (case of Malawi).

Basing on the above results, the project offered a unique opportunity for potato farmers in targeted countries to be exposed to improved production practices and attracted additional funding from Irish Aid in Malawi, Chevron in Angola, and USAID-bilateral mission in Mozambique. The SWOT analyses that were funded by the project enabled identification of key areas of intervention and write-up of project proposals.

It should be noted that research that generated new technologies such as new varieties and the aeroponics system for seed multiplication was completed at the end of the project. Continuous funding was required to make these technologies

useful to farmers. Fortunately, the co-funding from Irish Aid, Chevron and USAID bilateral mission was still available at the end of the SARRNET project.

#### Acknowledgement

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